Q(5) [redacted]

$n=1$, 300K, 10 atm, V_1 $\xrightarrow{\gamma=1.33}$ $n=1$, T, 1 atm, V_2

$q=0$

$\Rightarrow \Delta E = W$

$\Rightarrow -P\Delta V = nC_v\Delta T$

$\Rightarrow -1\times\left(\frac{1\times R\times T}{1} - \frac{1\times R\times 300}{10}\right) = 1\times 3R\times(T-300)$

$= -(T-30) = 3(T-300)$

$= 4T = 930$

$\Rightarrow T = 232.5$

$\Rightarrow \Delta E = W = nC_v\Delta T = 1\times 3\times 8.314\times(232.5-300)$

$\Rightarrow \boxed{W = -1.683\,KJ}$.

Q(6) [redacted]

$n=1$, $\gamma=\frac{4}{3}$, T = 300K, V $\xrightarrow{\text{reversible adiabatic}}$ T, 27V

$TV^{\gamma-1} = C$

$300\,V^{1/3} = T\times(27V)^{1/3}$

$\Rightarrow \boxed{100K = T}$.

$\Delta E = W = 1\times 25.08\times(100-300) = \underline{\underline{5016\,J}}$.

Q.7

$V \xrightarrow[\text{and}]{\text{reversible}} 2V$

298.15K adiabatically. 248.44K

$TV^{\gamma-1} = C$

$298.15\ V^{R/C_V} = 248.44 \times (2V)^{R/C_V}$

$\frac{298.15}{248.44} = (2)^{R/C_V}$

$\log\left(\frac{298.15}{248.44}\right) = \frac{R}{C_V} \log 2$

$0.079 = \frac{2.5}{C_V}$

$\Rightarrow C_V = 31.6\ JK^{-1}mol^{-1}$

$\frac{C_P}{C_V} = \gamma$

$C_P - C_V = R$

$\gamma - 1 = \frac{C_P}{C_V} - 1$

$= \frac{C_P - C_V}{C_V} = \frac{R}{C_V}$

Q.8

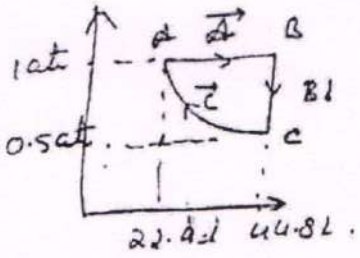
$n = 1$

$w = -1 \times 8.314 \times 298 \times \ln\left(\frac{5}{1}\right)$

$w = -3987.5\ J$ Ans

Q.9

$n = 1$ monoatomic



$T_A = \frac{1 \times 22.4}{0.082} = 1273\ K$

$T_B = \frac{1 \times 44.8}{0.082} = 546\ K$

$T_C = \frac{0.5 \times 44.8}{0.082} = 273\ K.$

For process $\vec{A}$

Isobaric.

$\Delta E = 1 \cdot \frac{3}{2} \times R \times 273.$

$q = \Delta H = 1 \times \frac{5}{2} \times R \times 273$

$w = \Delta E - q = -R \times 273$

For process $\vec{B}$

$w = 0.$

$q = \Delta E = 1 \times \frac{3}{2} R \times (-273)$

For process $\vec{C}$

$\Delta E = \Delta H = 0.$

$w = (-q) = -1 \times 8.314 R \times 273 \ln \frac{22.4}{44.8}$

$= -R \cdot 273 \ln \frac{1}{2}.$

$= +R \cdot 273 \times \ln 2$

Q(10) $q = +1$ Kcal.

$V = 1.2$ L. $\longrightarrow$ 1.5 L.

O_2

$P = 1$ atm $\longrightarrow$ 1 atm

$\Rightarrow q = \Delta H$ (constant pressure process)

$\Rightarrow \Delta H = +1$ Kcal.

$\because \Delta H = \Delta E + P\Delta V$.

$\Rightarrow \Delta E = 1\text{ Kcal} - \frac{(1 \times 0.3) \times 100}{4.2} = 0.993$ Kcal

Q(11) $\Delta H = 1440$ cal.

$\therefore \Delta H = \Delta E + P\Delta V$.

$\Rightarrow \Delta H = \Delta E + 1 \times (0.018 - 0.0196)$ atm.l.

$\Rightarrow \Delta E = 1440\text{ cal} + \frac{0.0016 \times 100}{4.2}$

$= 1440 + 0.038$ cal.

≈ 1440

Q(12) $w = -1 \times (1.1 - 1)$,

$\Rightarrow -0.1$ atm.l. $\quad 1$ atm.l $= 100$ J.

$= -10$ J

Q(13) (00)

$q = \Delta H = -36.5\,KJ.$

$w = -1 \times 500cm^2 \times 50cm$

$= -1\,atm \times 25\,l$

$= -25\,atl$

$\approx 2500\,J.$

$\Delta H = \Delta E + P\Delta V$

$\Delta E = -36.5\,KJ - 2.5\,KJ.$

$\approx -39\,KJ.$

Q(14) (00)

$n = 2.$ $\quad n = 2$

$C_v = \frac{5R}{2}$ $\quad V$ $\quad 2 \times V = 2 \times RT.$

$T = 300K$ $\quad T$ $\quad \Rightarrow V = RT.$

$P = 5at \longrightarrow P = 2at$

$P_{ext} = 1\,atm$

$q = 0$ Adiabatic

$\Delta E = q + w$

$\Rightarrow w = \Delta E$

$\Rightarrow -P_{ext} \times \Delta V = n C_v \Delta T.$

$= -1 \times (V_2 - V_1) = 2 \times \frac{5}{2} \times R \times (T_2 - T_1)$

~~$= -1 \times RT =$~~

$5 \times V_1 = 2 \times R \times 300$

$V_1 = \frac{600R}{5}.$

$V_2 = RT.$

$\Rightarrow -1 \times \frac{600R}{5}$

$= -1 \times \left(RT - \frac{600}{5}R\right) = 5R(T - 300)$

$= \frac{600}{5} - T = 5T - 1500 \Rightarrow 6T = 1620.$

$T = 270K$

$\Rightarrow \Delta E = W = 2 \times \frac{5}{2} R \times (270-300) = -1247.1$.

$\Delta H = 2 \times \frac{7}{2} R \times (270-300) = -1745.9$ J.

Q(15) Q.(10). $n = 5$ $n = 5$

$T = 300$ K. isothermal $T = 300$.

$P_i = 4$ $P = 1$.

$P_{ext} = 1$ atm

$V_1 = \frac{5 \times 0.082 \times 300}{4}$ $V_2 = \frac{5 \times 0.082 \times 300}{1}$

$= 30.75$ l $V_2 = 123$ l.

$\therefore W = -1 \times (123 - 30.75) \times 101.325$ J.

$W \approx -9347$ J.

reversible

$W = -5 \times 8.314 \times 300 \ln\left(\frac{4}{1}\right)$

$W = 17.288$ KJ

Q.(4) $n=3$ · reversible $n=3$

$T=200K$ ⟶ $T=250K$

$P=2$ atm Adiabatic V_2

V_1

$C_v=27.5$

$\Rightarrow 2\times V_1 = 3\times 0.082\times 200$

$V_1 = 3\times 0.082\times 100$ ·

$V_1 = 0.246\,\ell \times 100 = 24.6\,\ell$

~~$TV^{\gamma-1}$~~ $= C$. $\boxed{Q=0}$

$W = \Delta E = n C_v \Delta T = 3\times 27.5\times(250-200) = \boxed{4.125\,KJ}$

$\Delta H = 3\times(27.5+8.314)\times 50 = \boxed{5.372\,KJ}$

~~$\Delta E = W$~~ ·

$TV^{\gamma-1} = C$ ·

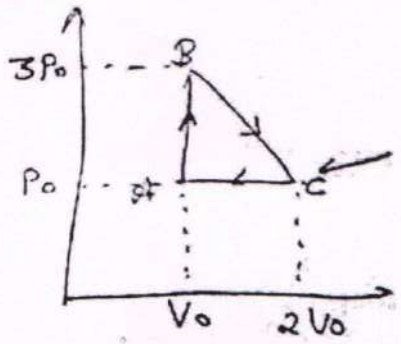
$\gamma = \frac{C_p}{C_v} = \frac{35.814}{27.5} = 1.3$ ·

$\Rightarrow 200\times(24.6)^{0.3} = 250\,V^{0.3}$ ·

$\left(\frac{200}{250}\right)^{\frac{10}{3}} \times 24.6 = V \Rightarrow \boxed{V = 11.7\,\ell}$

$P = \frac{3\times 0.082\times 250}{11.7} \Rightarrow \boxed{5.256\,atm}$

9. (17) : $n = 1$.



(a) $W = \frac{1}{2} \times V_0 \times 2P_0$

$W = -P_0V_0$

Work done by the gas: P_0V_0.

(b) $\overrightarrow{CA}$.

$W = P_0 \times V_0$.

$T_A = P_0V_0/R$

$T_B = 3P_0V_0/R$

$T_C = 2P_0V_0/R$

$\Delta E = 1 \times \frac{3}{2} R \times \left[\frac{P_0V_0}{R} - \frac{2P_0V_0}{R}\right]$

$\Delta E = \frac{3}{2} \times -P_0V_0 = -\frac{3P_0V_0}{2}$

$\because \Delta E = q + W$

$\Rightarrow q = -\frac{3}{2}P_0V_0 - P_0V_0$

$\boxed{q = -5/2 P_0V_0}$

$\overrightarrow{AB}$

$W = 0$.

$\Delta E = 1 \times \frac{3R}{2} \times \left(\frac{3P_0V_0}{R} - \frac{P_0V_0}{R}\right)$

$\Delta E = 3P_0V_0$.

(c).

$$\frac{y-3P_0}{x-V_0} = \frac{3P_0-P_0}{V_0-2V_0}$$

$$\frac{P-3P_0}{V-V_0} = \frac{2P_0}{-V_0}$$

$PV = mRT$.

$P \times V = 1 \times RT$.

$$\frac{RT}{V} - 3P_0 = -\frac{2P_0}{V_0} \times (V-V_0)$$

$$\frac{RT}{V} = -\frac{2P_0}{V_0}(V-V_0) + 3P_0$$

$$\frac{RT}{V} = +P_0\left[\frac{-2V+2V_0+3V_0}{V_0}\right]$$

$$\frac{RT}{V} = \frac{+P_0}{V_0}(5V_0-2V)$$

$$T = \frac{+P_0}{RV_0}(5V_0V-2V^2)$$

$$\frac{dT}{dV} = \frac{+P_0}{RV_0}(5V_0-2\cdot 2V)$$

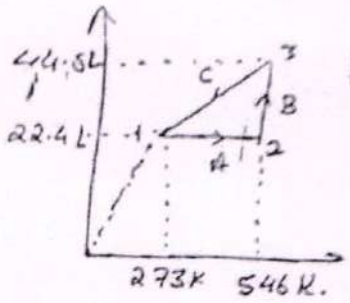
$$\Rightarrow V = \frac{5V_0}{4}$$

$$T = \frac{+P_0}{RV_0} \times \left[5 \times V_0 \times \frac{5V_0}{4} - 2 \times \left(\frac{5V_0}{4}\right)^2\right]$$

$$T = \frac{+P_0}{RV_0} \times 5^2 V_0^2 \left(1-\frac{1}{2}\right)$$

$$\boxed{T = \frac{25}{8}\frac{P_0V_0}{R}} \text{ A.}$$

Q.18



$P_1 = \frac{1 \times 0.082 \times 273}{22.4} = 1\,at$

$P_2 = \frac{1 \times 0.082 \times 546}{22.4} = 2\,at$

$P_3 = \frac{1 \times 0.082 \times 448}{546} = 1\,at$

A is isochoric

$\omega = 0$.

$q = \Delta E = 1 \times \frac{3}{2} \times 8.314 \times (546 - 273) = 3404.583\,J$

$\Delta H = 1 \times \frac{3}{2} \times 8.314 \times (546 - 273)$

B is isothermal

$\Delta E = \Delta H = 0$ (546 K)

$\Delta E = q + \omega$

$\omega = -q = -1 \times R \times 546 \ln\left(\frac{44.8}{22.4}\right) = -R \ln 2 \times 546$.

C is isobaric

$\Delta E = 1 \times \frac{3}{2} \times R \times (-273)$

$\Delta H = 1 \times \frac{5}{2} \times R \times (-273)$

$q = \Delta H = 1 \times \frac{5}{2} \times R \times 273$

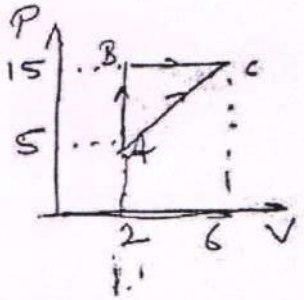
$\Delta E = q + \omega$

$-\frac{3}{2} R 273 = -\frac{5}{2} R \times 273 + \omega$

$\omega = R \times 273$.

Q.19

(a) Area under the curve AC is least thus w is least for process AC.



(b) $q_{AC} = +200J$

$w = \frac{1}{2} \times (5+15) \times 4$

$= \frac{1}{2} \times 20 \times 4 = 40J$

$w = -40J$

$\because \Delta E = q + w$

$\Rightarrow E_C - E_A = +200 - 40$

$\Rightarrow E_C = 160 + 10 = 170J$

(c) $W_{AB} = 0$

$q = \Delta E$

$\Rightarrow \boxed{q = 10J}$

Q.20

$\Delta H = \Delta E + P\Delta V$

$= \Delta E + \Delta n RT$

$= -14.2 \times 100$ Kcal/mol $+ \frac{1 \times 8.314 \times 300}{1000 \times 4.2}$

$= (-14.2 + 0.6)$ Kcal

$= -13.6$ Kcal

Q.21

$q = nc\Delta T$

$= \frac{213.5}{18} \times 18 \times 75$

$= 16.0125 \text{ Kcal}$

Q.22

$V_1 = 3 dm^3 \longrightarrow 5.0 dm^3$

$P_{ext} = 3 atm.$

$\Rightarrow w = -3 \times 2 atm\,l. \approx -6 \times 100 J$

$q = w \quad \because q = mc\Delta T \ (\because c \text{ in } g^{-1})$

$\Rightarrow 6 \times 100 = 180 \times 4.18 \times \Delta T$

$0.8 \approx \Delta T$

$\Rightarrow T - 290 = 0.8$

$\Rightarrow \boxed{T = 290.8 K}$

Q. 25 $\Delta S = \frac{\Delta H}{T} \Rightarrow 29.4 = \frac{4.60 \times 10^3}{T}$

$\Rightarrow T \approx 156.5\,K$.

Q.26 $\oint \frac{dq_{rev}}{T} = \oint ds$

since ds S is a state function
cyclic integral will be zero

Q.27 $28.8 = \frac{30.5 \times 10^3}{T}$

$\Rightarrow T = 1059\,K$

Q.28 $ds = \int \frac{dq}{T}$

$ds = \int \frac{C_p dT}{T}$

$= \int \frac{25.5}{T} + \int 13.6 \times 10^{-3} - \int 42.5 \times 10^{-7} T$

$= 25.5 [\ln T]_{300}^{600} + 13.6 \times 10^{-3} (600 - 300) - 42.5 \times 10^{-7} \times \left[\frac{T^2}{2}\right]_{300}^{600}$

$= 25.5 \ln 2 + 13.6 \times 10^{-3} \times 300 - \frac{42.5 \times 10^{-7}}{2} \times (600^2 - 300^2)$

$= 17.67 + 4.08 - \frac{42.5}{2} \times 10^{-7} \times (6^2 - 3^2) \times 10^4$

$= 17.67 + 4.08 - 573.75 \times 10^{-3}$

$= 21.177\ J\,K^{-1}\,mol^{-1}$

Q.29 $\Delta S = 2 \times 239.7 - (52.3 + 223)$

$= 479.4 - 375.3$

$= 104.1 \text{ J mol}^{-1}\text{K}$

$\Delta G = 29300 - 298 \times 104.1$

$= -1721.8 \text{ J}$

Q.30 $\Delta G = \Delta H - T\Delta S$

$\Rightarrow = -2808 \times 10^3 - 310 \times 182.4$

$= -2864.5 \text{ KJ}$

Q.31 $Na(s) + \frac{1}{2} Cl_2(g) \longrightarrow NaCl(s)$

$\Delta S = 72 - \left[51 + \frac{223}{2}\right] = -90.5 \text{ JK}^{-1}\text{mol}^{-1}$

$\frac{1}{2} N_2 + 2H_2 + \frac{1}{2} Cl_2 \longrightarrow NH_4Cl(s)$

$\Delta S = 95 - \left(\frac{1}{2} \times 2.43 + 2 \times 5.69 + \frac{1}{2} \times 223\right)$

$= 95 - 112.715 + 2 \times 5.69$

$\Delta S = 95 - \left[\frac{1}{2} \times 192 + 2 \times 131 + \frac{1}{2} \times 223\right]$

$95 = (96 + 262 + 111.5)$

$95 - 469.5$

$-374.5 \text{ JK}^{-1}\text{mol}^{-1}$

$Na \rightarrow 51$
$Cl_2 \rightarrow 223$
$NaCl \rightarrow 72$
$NH_4Cl \rightarrow 95$
$N_2 \rightarrow 192$
$H_2 \rightarrow 131$
dia $\rightarrow 2.43$
gra $\rightarrow 5.69$

$C(gra) \longrightarrow C(dia)$

$\Delta S = -[5.69 - 2.43] = -3.26 \text{ JK}^{-1}\text{mol}^{-1}$

Q.32

$\Delta H = -106.7 - (-139.3) = 32.6$ KJ/mol.

$\Delta G = 32.6 \times 10^3 - 298 \times 94.98$

$= 32600 - 28304$

$= +ve$

Thus does not occur spontaneously.

Q.33

$CO(g) + \frac{1}{2} O_2(g) \longrightarrow CO_2(g)$

$\Delta H^\circ = -393.5 - [-110.5 + 0]$

$\Delta H^\circ = -283$ KJ/mol.

$\Delta S^\circ = 213.7 - [197.6 + \frac{1}{2} \cdot 205]$

$\Delta S^\circ = -86.4$ JK^{-1}mol.

$\Delta G^\circ = -283000 - 298 \times (-86.4)$

$\Delta G^\circ = +257.25$ KJ

Q.34

$\Delta H = \Delta E + (1) \times 8.314 \times 298$

$\Delta H = -10.46 - \frac{2477.5}{1000}$

$= -12.9375$

$\Delta G = -12.94 \times 10^3 - 298 \times (-43.83)$

$= 151$ J.

$= +0.151$ KJ mol^{-1}

non feasible.

6.35

$H_2O + (O) \longrightarrow H_2 + (O_2)$

(I) $\Delta H = -94.05 - [-57.8 - 26.42] = -9.83$ Kcal/mol

(II) $\Delta g = 0 + -94.24 - [-54.64 - 32.79]$

$= -6.81$ kcal/mol

(III) $-6.81 \times 10^3 = -9.83 \times 10^3 - 298 \times \Delta S$

$\Rightarrow \boxed{\Delta S = -10.13 \text{ cal}}$

(IV) $\Delta H = \Delta E \quad (\because \Delta n = 0)$

$\Rightarrow \Delta E = -9.83$ kcal/mol

(V) $\Delta S = 31.2 + 81.1 - [x + 47.3] = -10.13$

$= +45.13$ cal mol^{-1} K^{-1}

Q.36 $\frac{1}{2}H_2 + \frac{1}{2}Cl_2 \longrightarrow HCl$. $\Delta H = -22.1$ Kcal.

$$\frac{\Delta H_{350} - \Delta H_{300}}{350 - 300} = 1 \times 6.8 - \left[\frac{1}{2} 6.82 + \frac{1}{2} 7.7\right],$$

$$\frac{\Delta H_{350} - -22.1 \text{ Kcal.}}{50} = 6.8 - 7.26 = -\frac{0.46}{1000}$$

$$\Delta H_{350} + 22.1 \text{ Kcal} = -\frac{23.}{1000}.$$

$$\Rightarrow \boxed{\Delta H_{350} = -22.123 \text{ Kcal}}$$

Q.37

$1m^3 = 1000l$

$\Rightarrow 1000l = \frac{1000}{22.4}$ mole

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

$\Delta H = -241.6 - 2.398.8 - (-76.2)$.

$= -241.6 - 2\times 398.8 + 76.2$

$= -963$ KJ/mol

$\Delta H = -398.8 - 2\times 241.6 - (-76.2)$

805.8 KJ/mol

∴ Heat evolved $= \frac{1000}{22.4} \times 805.8$ KJ/mol

$= 35973$ KJ

$= 35.973$ MJ.

Q.38

$C_2H_6 + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$.

$\Delta H_{comb^n} = -\frac{3120}{2}$

$\Rightarrow -\frac{3120}{2} = [2\times -395 + 3\times -286] - \Delta H_f^\circ(C_2H_6)$

$\Delta H_f^\circ(C_2H_6) = -(790 + 858) + \frac{3120}{2}$

$= -1648 + 1560$

$= -88$ KJ/mol

Q.39 ∴ $C(s) + 2S(\text{standard}) \longrightarrow CS_2$.

$+1 \times C(s) + O_2 \longrightarrow CO_2$ $\quad -393.3$

$+2 \times S(s) + O_2 \longrightarrow SO_2$ $\quad -293.72$

$-1 \times CS_2 + 3O_2 \longrightarrow CO_2 + 2SO_2$ $\quad -1108.76$

$\Rightarrow \Delta H_{reaction} = +108.76 + [-393.3 + 2 \times -293.72]$

$= +1108.76 \ominus [393.3 + 2 \times 293.72]$

$= -820 \text{ KJ}$. $+128.02 \text{ KJ}$

$=$

Q.40 $HgO(s) \longrightarrow Hg(g) + 1/2\ O_2(g)$

$\Delta H_{reaction} = [0 + \frac{1}{2} \times 0] - (-90.8 \text{ KJ mol}^{-1})$

$= +90.8 \text{ KJ/mol}$.

1 mole $HgO \longrightarrow 90.8 \text{ KJ}$

$\frac{41.84}{90.8}$ mole $HgO \longleftarrow 41.84 \text{ KJ}$.

0.46 mole HgO = mole gHg = 0.46

(C_2H_6)

$wt = (200.6) \times 0.46 = 92.276$

$\therefore \Delta H = \Delta E + \Delta n RT$.

$\underset{KJ}{90.8} = \Delta E + \frac{1}{2} \times \frac{8.314 \times 298}{1000}$.

$90.8 \text{ KJ} = \Delta E + 1.24 \text{ KJ}$.

$89.56 \text{ KJ} = \Delta E$ $\Rightarrow$ $89.56 \text{ KJ} \longrightarrow 1 \text{ mole Hg}$

$\Rightarrow 41.84 \text{ KJ} \longrightarrow \frac{41.84}{89.56} \text{ mole}$

$$wt = \frac{41.84}{89.56} \times 200.6 = 93.7\ g.$$

Q.41 :— $C_2H_4(g) + H_2(g) \longrightarrow C_2H_6$.

$$\Rightarrow \Delta H = -1410.8 + (-285.9) - [-1559.8]$$

$$= -1410.8 - 285.9 + 1558.8$$

$$\Delta H = -136.9\ KJ.$$

Q.42 :— 14 Kg of butane.

1 mole butane $\longrightarrow$ 2658 KJ heat.

1 day $\longrightarrow 20 \times 10^6$ J.

26 day $\longrightarrow 26 \times 2 \times 10^7$ J $= 52 \times 10^7$ J.

520,000 KJ

$C_4H_{10} \Rightarrow 12 \times 4 + 10 = 48 + 10 = 58$ g.

$\Rightarrow$ 58 g $\longrightarrow$ 2658 KJ.

14000 g $\longrightarrow \frac{2658 \times 14000}{58}$ KJ

641,586.2 KJ.

$\Delta = 121586$

$\therefore \% = \frac{121586}{641586} \times 100$

$= 18.95\ \%$

Q.43 $NH_4NO_3(s) \longrightarrow N_2O(g) + 2H_2O(l)$

$\Rightarrow \Delta H_{reaction} = 81.66 + 2x - 285.78 - (-367.5)$

$= -122.6$ KJ.

Q.44 35. $\Delta H = -337 + 68.4 - (-373)$

$= -32.3$ Kcal

8.56 (32) (33) - Dulong's and petit law

$0.0276 \times At.wt \approx 6.4$

$\Rightarrow At.wt \approx 232.$

8.58 (33) $CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$

$+1 \int CuSO_4 \longrightarrow Cu^{+2} + SO_4^{-2} \quad -15.9\ Kcal.$

$-1 \int CuSO_4.5H_2O \longrightarrow Cu^{+2} + SO_4^{-2} + 5H_2O \cdot 2.8\ Kcal$

$\Rightarrow -15.9$

2.8

-18.7

$\Rightarrow \underline{\Delta H = -18.7\ Kcal.}$

8.59 (34) ~~$NH_4OH + HF \longrightarrow H_2O + NH_4F$~~

$NH_4OH + H^+ \longrightarrow NH_4^+ + H_2O.$

$H^+ + OH^- \longrightarrow H_2O + 13.6\ kcal = 56.8\ KJ.$

$\therefore -51.5 = -56.8 + \Delta H$

$\Rightarrow \Delta H = \underline{+5.348\ KJ}.$

$HF + OH^- \longrightarrow H_2O + F^-$

$-68.6 = -56.8 + \Delta H.$

$\Rightarrow \Delta H = 11.8\ KJ.$

Foundation Builder (Subjective)

Q.1 $W = +nRT\ln\frac{P_1}{P_2}$

$= 1 \times 8.314 \times 298 \ln\left(\frac{1}{5}\right) = -3.988\ KJ$

Q.2 16 g of O_2

$V = 0.5\ lt \longrightarrow 4\ lt$

$T = 298\ K$

$TV^{\gamma-1} = \text{constant}$

$298 \times (0.5)^{V_3} = T \times 4^{V_3}$

So, $T = 149\ K$

Q.3 $\Delta E = q + w = (-65) + (+20) = -45\ J$

Q.4 $CaCO_3 \rightarrow CaO + CO_2$

$q = \Delta H = 177.9\ KJ$

$\Delta H = \Delta E + P\Delta V$

So, $\Delta E = 177.9 \times 1000 - 1 \times \left[24.4 + \frac{16.9}{1000} - \frac{34.2}{1000}\right]$

$= 175.4\ KJ$

(2) $\Delta H = (80 + 596) \times 1.8$ cal

$= 12168$ cal.

$\Delta E = 12168 - 1 \times 2 \times 273 = 11622$ cal.

(3) $P_1 = \frac{2 \times R \times 300}{20} = 30R$

$V_1 = 20L$

$T_1 = 300K.$

$P_2 = P_1 = 30R$

$V_2 = 40\ L$

$T_2 = 600\ K.$

$T_3 V_3^{\gamma-1} = T_2 V_2^{\gamma-1}$

$V_3 = 40 \times \left(\frac{600}{300}\right)^{\frac{1}{\gamma-1}} = 113.13\ L$

$P_3 = \frac{2 \times R \times 300}{113.13} = 0.435$ atm.

$W = -2 \times R \times (600 - 300) + 2 \times \frac{3}{2} R \times (300 - 600)$

$= -600R - 900R = -1500R = -3000$ cal.

(4) (i) $\Delta U = \Delta H = 0$

$$-Q = W = -20\times10^{-3} \times 0.7\times10^{6} \ln \frac{0.7}{0.2}$$

$$= -17.54 \text{ kJ}$$

(ii) $Q = 0$ $\qquad T_f = 673\left(\frac{0.7}{0.2}\right)^{\frac{1-\lambda}{\lambda}} = 470.5$

$$\Delta U = W = \frac{5}{2} \frac{14\times10^{3}}{673}(470.5 - 673)$$

$$= -10.53 \text{ kJ}.$$

$$\Delta H = \frac{7}{2} \frac{14\times10^{3}}{673}(470.5 - 673)$$

$$= -14.75 \text{ kJ}$$

(iii) $Q = 0$, $\Delta U = \Delta H = 0$, $W = 0$

(iv) $Q = 0$

$$n \times \frac{5}{2} R \times (T_f - 673) = -0.2\left(\frac{nRT_f}{0.2} - \frac{nR\times673}{0.7}\right)$$

$$\Rightarrow \frac{7}{2} T_f = \frac{5}{2}\times673 + \frac{2}{7}\times673 = 535.65$$

$$W = \Delta U = \frac{5}{2} \times \frac{14\times10^{3}}{673}(535.65 - 673)$$

$$= -7.14 \text{ kJ}$$

$$\Delta H = -10 \text{ kJ}$$

(v) $\Delta U = \Delta H = 0$

$$-Q = W = -0.2\left(\frac{nRT}{0.2} - \frac{nRT}{0.7}\right)$$

$$= -14\times10^{3} \times \frac{5}{7} = -10 \text{ kJ}$$

(5)

1 atm, 298 K ⟶ 1 atm, 373 K.

$\Delta U = 1 \times \frac{3}{2} R \times 75 = 935.33\ J$

$W = -1 \times R \times 75 = -623.55\ J$

$Q = \Delta H = 1558.88\ J$

1 atm, 373 K ⟶ 0.5 atm, 373 K

$\Delta U = \Delta H = 0$

$W = -1 \times R \times 373 \ln 2 = -2149.53\ J$

$Q = -W$

0.5 atm, 373 K $\xrightarrow{Q=0}$ 308 K

$Q = 0$

$W = \Delta U = 1 \times \frac{3}{2} R \times (308 - 373)$

$= -810.62\ J.$

$\Delta H = 1 \times \frac{5}{2} R \times (308 - 373)$

$= -1351.03\ J.$

(6) (i) $Na + \frac{1}{2}Cl_2 \longrightarrow NaCl$

$$\Delta S = 72 - 51 - \frac{223}{2}$$

$$= -90.5$$

(ii) $\frac{1}{2}N_2 + 2H_2 + \frac{1}{2}Cl_2 \longrightarrow NH_4Cl$

$$\Delta S = 95 - \frac{192}{2} - 2 \times 131 - \frac{223}{2}$$

$$= -374.5$$

(iii) $C\ (gr) \longrightarrow C\ (d)$

$$\Delta S = 2.43 - 5.69$$

$$= -3.26$$

(7) (i) $\Delta S_{gas} = R \ln 3$

$$\Delta S_{surr} = -\Delta S_{sys}$$

$$\Delta S_{tot} = 0$$

(ii) ~~$\Delta S_{gas} = RT \ln 3 = 83$~~

$$\Delta S_{gas} = R \ln 3$$

$$\Delta S_{surr} = -\frac{RT \ln 3 - 836.8}{298}$$

$$\Delta S_{tot} = \frac{836.8}{298} = 2.808.$$

(iii) $\Delta S_{sys} = R \ln 3$

$\Delta S_{surr} = 0$

$\Delta S_{tot} = R \ln 3 = 9.134 \text{ J/K}.$

(8) $n = \frac{10}{20} = 0.5$

(i) $\Delta S_{sys} = \Delta S_{surr} = \Delta S_{tot} = 0$

(ii) $\Delta S_{surr} = 0$

$n \times \frac{3}{2} R \times (T_f - 473) = -2\left(\frac{nRT_f}{2} - \frac{nR \times 473}{5}\right)$

$\Rightarrow \frac{3}{2} T_f - \frac{3}{2} T_i = -T_f + \frac{2}{5} T_f$

$\Rightarrow \frac{5}{2} T_f = \frac{19}{10} T_i$

$\frac{T_f}{T_i} = \frac{19}{25}$

$\frac{V_f}{V_i} = \frac{19}{25} \times \frac{5}{2} = \frac{19}{10}$

$\Delta S_{sys} = \frac{1}{2} \times \frac{3}{2} R \ln \frac{19}{25} + 1 \times \frac{1}{2} \times R \ln \frac{19}{10}$

$= 0.957.$

(iii) $\Delta S_{surr} = 0$

$\frac{T_f}{T_i} = 1 \Rightarrow \frac{V_f}{V_i} = \frac{5}{2}$

$\Delta S_{sys} = \frac{1}{2} R \ln \frac{5}{2} = 3.81 \text{ J/K}.$

(9)

V, 298K ⟶ V, 373K

$W = 0$

$\Delta U = Q = C_V \times 75 = 75 C_V$.

$\Delta H = 75 C_p$.

V, 373K ⟶ (free expansion) ⟶ 2V, 373K.

$W = 0$

$\Delta U = 0$

$\Delta H = 0$

$Q = 0$

2V, 373K ⟶ (constant P.) ⟶ 298K

$\Delta U = -75 C_V$

$Q = \Delta H = -75 C_p$

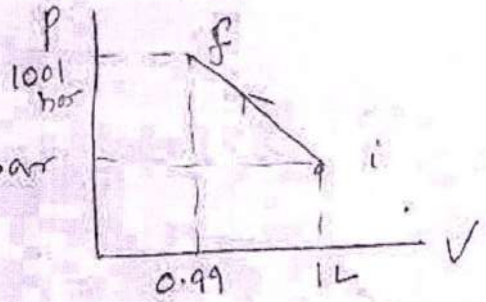
$W = 75R$.

$W_{tot} = 75R = 623.55\ J$

$\Delta H_{tot} = \Delta U_{tot} = 0$

$Q_{tot} = -75R = -623.55\ J$

(10)



$W = \frac{1}{2} \times 0.01 \times 1002 = 5.01$ Lt. ~~atm~~, bar
$= 501$ J

$Q = 0$

$\Delta U = 5.01$ Lt. atm

$\Delta h = 5.01 + 989.99 = 995$ Lt. ~~atm~~. bar
$= 99500$ J

(11)

$V - 10 = \frac{5}{300}(T - 300)$

~~$W_{AB} = \frac{1}{2}(300+600) \times 300$~~

$T = \frac{PV}{R}$

~~$V - 10 = 5T$~~

$$W_{AB} = -\int_{10}^{15} \frac{(60(V-10)+300)R}{V} dV$$

$$= -R\left(60 \times 5 - 300 \ln\left(\frac{15}{10}\right)\right)$$

$$= \boxed{-1496.52 \text{ J}}$$

W_{BC} = Isothermal $= -nR(600)\ln\left(\frac{V_2}{V_1}\right)$

$= -1 \times 8.314 \times 600 \ln\left(\frac{20}{15}\right)$

$= \boxed{-1446.63 \text{ J}}$

W_{CD} (Isochoric) $= 0$

$W_{DA} = +nR(300)\ln\left(\frac{10}{20}\right) = \boxed{1728.84\,J}$

(ii) $q_{AB} = \Delta U_{AB} - W_{AB}$

$= n\left(\frac{R}{\gamma-1}\right)(300) - (-1496.52)$ (n = 1, R = 8.314, $\gamma = 5/3$)

$= \boxed{5237.82\ J}$

$q_{BC} = \cancel{\Delta U_{BC}}^{\,0} - W_{BC}$

$\boxed{q_{BC} = 1446.63\,J}$

$q_{CD} = \Delta U_{CD} - \cancel{W_{CD}} = 1\times\left(\frac{R}{\gamma-1}\right)\times(-300)$

$= \boxed{-3741.3\,J}$

$q_{DA} = \cancel{\Delta U_{DA}}^{\,0} - W_{DA}$

$\boxed{q_{DA} = -1728.84\,J}$

(iii) $\Delta H_{AB} = nC_p\Delta T = 1\times(C_v+R)(300)$

$= \boxed{6235.5\,J}$

$\Delta H_{BC} = nC_p\cancel{\Delta T}^{\,0} = \boxed{0}$

$\Delta H_{CD} = nC_p\Delta T = 1\times(C_v+R)(-300)$

$= \boxed{-6235.5\,J}$

$\Delta H_{DA} = nC_p\cancel{\Delta T}^{\,0} = \boxed{0}$

(2)(i) $\Delta S_{system} = n C_v \ln\left(\frac{T_2}{T_1}\right) + nR \ln\left(\frac{V_2}{V_1}\right)$

$1 \quad \frac{R}{(\gamma-1)} \ln\left(\frac{1000}{100}\right) = \frac{3}{2} R \ln 10$

$$\boxed{\Delta S_{system} = \frac{3}{2} R \ln 10}$$

$$\boxed{\Delta S_{Total} = 0} = \Delta S_{system} + \Delta S_{surrounding}$$

($\because$ rev process)

$$\Delta S_{surrounding} = -\Delta S_{system}$$

$$\boxed{\Delta S_{surrounding} = -\frac{3}{2} R \ln 10}$$

(ii) Irreversible process: $\Delta S_{system} = \int \frac{q_{rev}}{T}$

$$\boxed{\frac{3}{2} R \ln 10}$$

$\Delta S_{surr} =$

(3) $n = 2$ mol $\quad P_1 = 101.325 \times 10^3$ Pa

$T_1 = 300$ K

$T_2 = 550$ K

(a) $W = -\int P dV = -P(V_2 - V_1)$

$= -nR(T_2 - T_1) = -2 \times 8.314 \times (250)$

$\boxed{W = -4.157 \times 10^3 \text{ J}}$

$q_p = \Delta H = nC_p \Delta T$

$= \int_{300}^{550} 2\left(12.552 + 8.368 \times 10^{-2} T\right) dT$

$= 6.27 \times 10^3 + 1.77 \times 10^4$

$\boxed{q_p = \Delta H = 24.058 \text{ KJ}}$

$\boxed{\Delta U = q_p + W = 19.90 \text{ KJ}}$

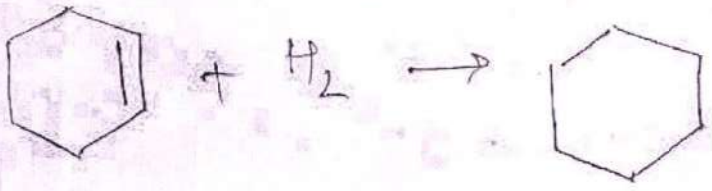
(b) $W = 0$

$\boxed{q_v = \Delta U = nC_v \Delta T = 19.90 \text{ KJ}}$

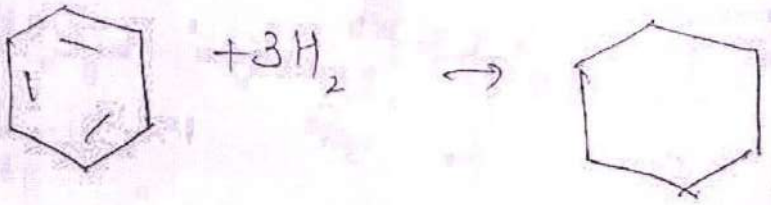
(State function : same)

$\boxed{\Delta H = nC_p \Delta T = 24.058 \text{ KJ}}$

Q14 $C_6H_6(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(g)$



$\Delta H = -119$ kJ/mol



$\therefore \Delta H = -119 \times 3 = -357$ kJ/mol

$-357 = \Delta H^\circ_f C_6H_{12} - (\Delta H^\circ_f C_6H_6 - \text{Resonance energy})$

$\Delta H_{combustion} = -(\Delta H^\circ_f C_6H_6 - \text{Resonance energy})$

$+ \Delta H^\circ_f O_2 \times \frac{15}{2} + 6\Delta H^\circ_f CO_2 + 3\Delta H^\circ_f H_2O$

$-357 = -156 - \Delta H^\circ_f C_6H_6 + (-152)$

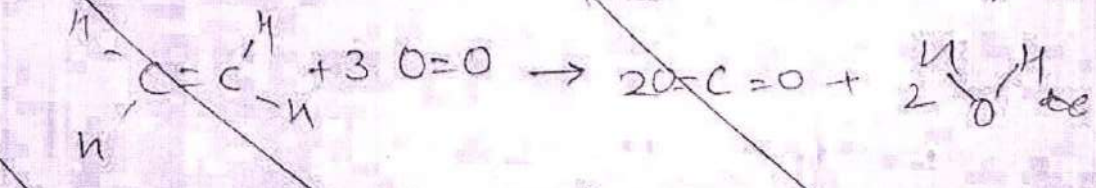
$\boxed{\Delta H^\circ_f C_6H_6 = 49 \text{ kJ/mol}}$

$\Delta H_{Combustion} = 6(-393.5) + 3(-285.8) - 1(49)$

$= \boxed{-3267.4 \text{ kJ}}$

Q5

$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O \quad \Delta H_1^\circ = -1559.8$

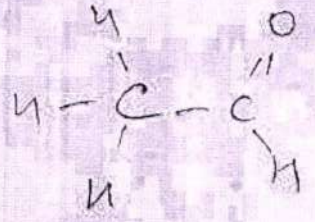


$4(C-H) + 1\times(C=C) + 3(O=O)$

$- 4(C=O) - 4(OH) = -1559.8$

$4(C-H) + 1\times(C=C) - 4(C=O) -$

15)



$+ 3O_2 \rightarrow 2CO_2 + 2H_2O$

$\Delta H = -1192.3$

$-1192.3 = 4(C-H) + 1(C=O) + (498.4)\times 3$

$- 4(C=O) - (285.8)\times 2$

$-1192.3 = 4(C-H) - 3(804.26) + 498.4\times 3$

$- 285.8\times 2$

$CH_3-\overset{\overset{O}{\|}}{C}-H + O_2 \Rightarrow CO_2 + H_2O$

$C_2H_4 + O_2 \Rightarrow 2CO_2 + H_2O$

1) $C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O \quad \Delta H_1$

2) $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O \quad \Delta H_2$

3) $C_2H_2 + \frac{5}{2}O_2 \rightarrow 2CO_2 + H_2O \quad \Delta H_3$

$\Delta H_1 = -1559.8 = 2\times(-393.5) + 3(-285.8) - \Delta H^\circ_f C_2H_6$

$\boxed{\Delta H^\circ_f C_2H_6 = -84.6\ KJ}$

$\Delta H_2 = -1410.9 = 2(-393.5) + 2(-285.8) - \Delta H^\circ_f C_2H_4$

$\boxed{\Delta H^\circ_f C_2H_4 = 52.90\ KJ}$

$\Delta H_3 = -1299.7 = 2(-393.5) + (-285.8) - \Delta H^\circ_f C_2H_2$

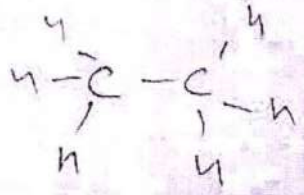
$\boxed{\Delta H^\circ_f C_2H_2 = 226.90\ KJ}$

$C_{(s)} + O_{2\,(g)} \rightarrow CO_2$

$\Delta H^\circ_{f\,CO_2} = -393.5 = 716.68 + 498.94 - 2(C=O)$

$\boxed{(C=O) = 804.26\ KJ}$

$$2C_{(s)} + 3H_2 \longrightarrow C_2H_6 \qquad \Delta H = -84.6$$



$$-84.6 = 2(716.68) + 3(435.94) + 1(C-C) + 6(C-H)$$

$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$$

$$-285.8 = 435.94 + \frac{1}{2}(498.94) - 2(O-H)$$

$$\boxed{(O-H) = 485.60\ J}$$

ADVANCE LEVEL

① (a) $(1)^{1-\gamma}\ (300)^{\gamma} = (2)^{1-\gamma}\ T_f^{\gamma}$ $\left(\gamma = 5/3\right)$

$T_f = 395.85\,K$

~~$W = 1 \times \frac{3}{2} R \times (\ldots)$~~

$W = 1 \times \frac{3}{2} R \times (395.85 - 300)$

$= 1195.4\,J$

$V_f = \frac{nRT_f}{P_f} = 16.25\,L$

(b). $1 \times \frac{3}{2} R (T_f - 300) = -2\left(\frac{nRT_f}{2} - \frac{nR \times 300}{1}\right)$

$\frac{3}{2} T_f - 450 = -T_f + 600$

$\frac{5}{2} T_f = 1050 \Rightarrow T_f = 420\,K$

$W = 1 \times \frac{3}{2} R \times (420 - 300) = 1496.52\,J$

$\therefore V_f = 17.24\,L.$

(16) (c) O_3 has highest C_v

(17) $\Delta U_R = -723 - 8.314 \times 0.3 \times (-1) = -69.8$ kJ/mole.

$n_{C_2H_4} = 3.5$, $n_{Ar} = 3$

So $\Delta U = -69.8 \times 3$ kJ $= -209.4$

(18) $W = -600R \ln\frac{1}{2} - 2R(400-300) - 800R \ln 2 - 2R(300-400)$

$= -200R \ln 2 = -100R \ln 4$

(19) $-3000 = 1 \times 20 \times (T_f - 300)$

$T_f = 150K$

(20) $2 \times \frac{5}{2}R \times (T_f - 350) = -2\left(\frac{2RT_f}{2} - \frac{2R \times 350}{1}\right)$

$\Rightarrow \frac{5}{2}T_f - \frac{5}{2} \times 350 = -T_f + 700$

$\Rightarrow \frac{7}{2}T_f = \frac{9}{2} \times 350 \Rightarrow T_f = 450K.$

$W = 2 \times \frac{5}{2}R \times (450-350) = 500R$

(21) $\eta = 1 - \frac{298}{373} = 22.2\%$

(22) $1 - \frac{300}{500} = \frac{w}{2} \Rightarrow w = 0.8 \text{ kcal}$

(23) $1 - \frac{T_2}{1000} = 1 - \frac{360}{T_2}$

$\Rightarrow T_2 = 600$

(24) $\Delta H = -3 + (-1)\frac{2 \times 300}{1000} = -3.6 \text{ kcal}$

$\Delta G = -3.6 + \frac{10 \times 300}{1000} = -0.6 \text{ kcal}$

(25) $\Delta S = nC_v \ln \frac{T_f}{T_i} = 2 \times \frac{3}{2} R \ln \frac{573}{473}$

(26) At phase eq $\Delta G = 0$

(27) $H_2O(l, 1\text{atm}, 373K) \longrightarrow H_2O(g, 1\text{atm}, 373k)$

$\Delta G = 0$

$H_2O(g, 1\text{atm}, 373K) \longrightarrow H_2O(g, 2\text{atm}, 373k)$

$\Delta G = \int V dP = nRT \ln \frac{P_f}{P_i}$

$= 373R \ln 2$

$$T_f = \frac{T_H + T_C}{2}$$

28

$$\Delta S_{tot} = \int_{T_H}^{T_f} ms\, d\frac{T}{T} + \int_{T_C}^{T_f} ms\, d\frac{T}{T}$$

$$= C_v \ln \frac{T_f}{T_H} + C_v \ln \frac{T_f}{T_C}$$

$$= C_v \ln \frac{T_f^2}{T_H T_C} = C_v \ln \frac{(T_H + T_C)^2}{4 T_H T_C}$$

29 S° of $H_2 > 0$ at 298K.

30 $\Delta H > 0$, $\Delta S > 0$

(+ve y intercept) (-ve slope)

(d) $dG = VdP - \cancel{SdT}^{\to 0}$ at Const. T

$$\left(\frac{\partial G}{\partial P}\right)_T = V$$

[S]

Get Equipped for IIT JEE

46. (a,b,c) at 400 K & 1 atm X(ℓ) is in equilibrium with X(g)

i.e. $\Delta G = 0$

at const. T

$$\Delta G = nRT \ln \frac{P_2}{P_1}$$

if $P_2 > P_1$ then $\Delta G = +ve$

if $P_2 < P_1$ then $\Delta G = -ve$

$$\Delta G = nRT \ln \frac{2}{1} > 0$$

$$\Delta G = nRT \ln \frac{0.1}{1} < 0$$

correct option a, b, c

47. (a,c,d) $\Delta S = nC_p \ln \frac{T_2}{T_1}$ ⊕ at const. P.

$T_2 > T_1$

$\Delta S = +ve$

$$\Delta H_2 = \Delta H_1 + \Delta C_p (T_2 - T_1)$$

$T_2 > T_1$

$\Delta H_2 > \Delta H_1$

$$\Delta G = \Delta H - T\Delta S$$

$T\Delta S > \Delta H$

$\Delta G < 0$

i.e. Process is Spontaneous.

correct option a, c, d

48- (a,b,c,d)

for adiabatic irreversible

$\Delta S_{sys} \neq 0$

for isothermal process

$\Delta S_{sys} = 0$

$\Delta G_{sys} = \Delta H - T\Delta S < 0$

if ΔH is +ve & ΔS is +ve at high T.

$dG = VdP - SdT$ is applicable for PV only

$$\Delta S_{system} = -\frac{n\Delta H_{vap}}{T} = -\frac{0.5 \times 40600}{373} = -54.42\ J\,K^{-1}$$

49- (b)

$$W = -nRT \ln \frac{P_i}{P_f}$$

$$W = -P_i V_i \ln \frac{P_i}{P_f}$$

$$W = -2 \times 8 \ln \frac{2}{20} = 36.848 \text{ bar L}$$

50- (c)

$$V_f = \frac{P_i V_i}{P_f} = \frac{2 \times 8}{20}$$

$$W = -P_{ext}(V_f - V_i)$$

$$= -20\left(\frac{2 \times 8}{20} - 8\right) = 144 \text{ bar L}$$

51- (b)

$$W = W_1 + W_2$$

$$W_1 = -P_{ext}(V_f - V_i)$$

$$= -10\left(\frac{2 \times 8}{10} - 8\right) = 64 \text{ bar L}$$

$$W_2 = -20\left(\frac{2 \times 8}{20} - \frac{2 \times 8}{10}\right) = 16 \text{ bar L}$$

$$W = W_1 + W_2$$

$$W = 64 + 16 = 80 \text{ bar L}$$

52. (a) $\Delta H_{neutralisation} = q - 55.84$

$-49.82 = q - 55.84$

$q = \boxed{5.98 \text{ KJ/mol}}$

53. (b)

$$Ca(OH)_2 + 2HNO_3 \longrightarrow Ca(NO_3)_2 + 2H_2O$$

$\Delta H = 2 \times \Delta H_{neutralisation}$

$= 2 \times (-55.84)$

$= \boxed{-111.68 \text{ KJ}}$

54. (b)

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

$V_{H_2SO_4} = V_1$

$V_{NaOH} = V_2$

$V_1 + V_2 = 100$

for max. temp. rise.

$0.05 V_1 \times 2 = 0.1 V_2$

$V_1 = V_2 = \boxed{50 \text{ mL}}$

55. (c) $\Delta H < 0$ for spontaneous rxn

$\Delta H - T\Delta S < 0$

$\Delta S > \frac{\Delta H}{T}$

$\Delta S > \frac{15000}{300} = \boxed{50 \text{ J mole}^{-1} \text{K}^{-1}}$

56- $\Delta G = \Delta H - T\Delta S$

$\Delta G = -T\Delta S$

$\Delta G = -T\left[-n_1 R \ln x_1 - n_2 R \ln x_2\right]$

$= 8.314 \times 298\left[4 \ln \frac{4}{5} + 1 \ln \frac{1}{5}\right]$

$\Delta G = \boxed{-6.19 \text{ KJ}}$

57- (a) $2CeCl_4(aq) + Zn(s) \longrightarrow 2CeCl_3(aq) + ZnCl_2(aq)$

$E = 0.4100 + 0.003T$

$\Delta S = -\frac{\partial(\Delta G)}{\partial T}$

$\Delta S = -\frac{\partial(-nFE)}{\partial T}$

$\Delta S = nF\frac{\partial E}{\partial T}$

$\Delta S = nF \times 0.003$

$\Delta S = 2 \times 96500 \times 0.003 = \boxed{579 \text{ JK}^{-1}}$

58- (A) Reversible Cooling at const. Volume

$\Delta V = 0$

$\boxed{W = 0}$

$T_2 < T_1$

$\boxed{\Delta U < 0}$

$\boxed{\Delta U = q < 0}$

$\boxed{P}$

(B) Reversible isothermal expansion

$\Delta T = 0 \Rightarrow \boxed{\Delta U = 0}$

$V_2 > V_1 \Rightarrow \boxed{W < 0} \Rightarrow \boxed{q > 0}$ $\boxed{S}$

(C) Adiabatic expansion in vacuum

$q = 0$

$P_{ext} = 0$ $V_1 \rightarrow V_2$ $\Rightarrow$ $W = 0$ $\Rightarrow$ $\Delta U = 0$

$V_2 > V_1$

R

(D) Reversible melting of sulphur at Normal melting point

heat required $\Rightarrow$ $q > 0$

$V_2 > V_1 \Rightarrow W < 0$

$\Delta U = q + W$

$q > W$

$\Delta U > 0$

Q

59. (A) reversible isothermal expansion

$W = -nRT \ln \frac{V_2}{V_1} = -2.303\, nRT \log \frac{V_2}{V_1}$

$\Delta H = 0$

(only for isothermal reversible)

P, S

(B) Reversible adiabatic expansion

$PV^{\gamma} = \text{Constant}$ (only for reversible adiabatic)

$W = \frac{nR}{\gamma - 1}(T_2 - T_1)$

Q, R

(C) Irreversible adiabatic expansion

$W = \Delta U = \frac{nR}{\gamma - 1}(T_2 - T_1)$ R

(D) Irreversible isothermal compression

$\Delta T = 0 \Rightarrow \Delta H = 0$

60. (A) $(\Delta G_{sys})_{T,P} = 0$ equilibrium

ΔG is useful work & here it is zero

[P, S]

(B) $\Delta S_{total} > 0$

spontaneous

[R]

(C) $\Delta S_{total} < 0$

non-spontaneous

[Q]

(D) $(\Delta G_{sys})_{T,P} > 0$ non-spontaneous

[Q]

61. (A) Heating of an ideal gas at const. pressure

$\Delta T \neq 0 \Rightarrow \Delta H = nC_p\Delta T$

[P]

(B) Compression of liquid at const. temp.

$\Delta U \neq nC_v\Delta T$ $\Delta G = V\Delta P + S\Delta T^{0}$

[R]

(C) Reversible Process for an ideal gas at const. T.

$\Delta T = 0 \Rightarrow \Delta U = n C_V \Delta T = 0$

$\Delta G = nRT \ln \frac{P_2}{P_1}$

[Q, S]

(D) Adiabatic free expansion of an ideal gas

$W = -P_{ext} \overset{0}{\Delta V} = 0$

$q = 0$

$\Delta U = 0$

[Q]

62.

(A) $\Delta U = n C_V \Delta T$

$\left(\frac{\partial U}{\partial T}\right)_V = C_V$ for 1 mole

[Q]

(B) $\Delta H = n C_p \Delta T$

$\left(\frac{\partial H}{\partial T}\right)_P = C_p$ for 1 mole

[P]

(C) $dG = V\overset{0}{dP} - S\,dT$ at const. P

$\left(\frac{\partial G}{\partial T}\right)_P = -S$

[R]